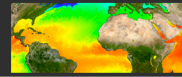


in affiliation with



INTERNATIONAL ACTION ON GLOBAL WARMING

A project of the Association of Science-Technology Centers on the occasion of International Polar Year, designed to raise worldwide public awareness about global warming and ways the polar regions profoundly influence Earth's climate, ecosystems, and human society.



Trees are Made from Air

Goal of Activity:

To highlight that trees are made from air and that when burning trees and fossil fuels releases CO₂ back into the air.

Audience

Ages: 5-16

Difficulty Level

Beginner- Intermediate

Materials Required

1. 1 tree limb
2. 1 tree seed (buckeye, acorn, etc)
3. Baking soda
4. Vinegar
5. Small water bottle
6. Spatula
7. Balloon
8. Piece of charcoal
9. Three glass beakers
10. Spinach leaves
11. Acetone or ethanol
12. Metal spoon
13. Filter paper
14. Funnel
15. Test tube
16. Big flashlight
17. Waste bucket

Estimated cost of materials: \$20

Instructions

Estimated time required to complete activity: 10-20 min
Preparation time: 30 min

I. Where did all the material come from to make the tree?

- a. Hand out a tree seed
- b. Hand out a tree branch
- c. Ask “Where did all the stuff come from to make the tree limb from the seed?”

II. Trees are made primarily from the CO₂ in air.

- a. Pour vinegar into bottle
- b. Put baking soda in balloon
- c. Put balloon on bottle, and invite guest to dump balloon baking soda into vinegar – result is carbon dioxide, the part of the “air” from which trees and other plants are made.
- d. Charcoal is mostly carbon – concentrated from wood. The carbon in charcoal comes from carbon dioxide in the air. When charcoal (and fossil fuels like coal and oil) are burned, that carbon is released back into the air.

III. How do trees do it?

- a. Hand out a leaf of spinach
- b. Have visitor tear up spinach and drop pieces in beaker
- c. Pour a small amount of nail polish remover or ethanol over spinach leaves
(CAUTION: provide adequate ventilation)
- d. Use metal spoon to mash spinach leaves
- e. Strain the liquid (contains chlorophyll) into test tube through filter paper
- f. Note the color change
- g. Shine light on chlorophyll solution and note the fluorescence

What’s Happening?

Trees contain a large percentage of carbon. They get this carbon from the CO₂ in the air through a process called “photosynthesis.” When we burn trees or other fossil fuels that were once organic matter, we release the carbon back into the air as CO₂.

In the spinach experiment, we separated chlorophyll from the spinach. When a light is shined on the chlorophyll it absorbs the energy. In a plant, that energy is used to form a

type of sugar from the CO₂. In this experiment, the chlorophyll is in the container by itself and rather than producing sugar, it releases the energy it absorbs as red light.

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Additional Background information

Trees and other plants contain large amounts of carbon and are made primarily from CO₂ through a process called photosynthesis. Under special geologic conditions, layers of plants can become buried and made into coal, which is mostly carbon. When we burn coal or other fossil fuels, we release the carbon back into the atmosphere as CO₂.

A script for “Trees are Made from Air” activity:

Hi, would you like to try our tree challenge? Let me start with a question. How many people here were ever babies? When you were a baby, were you smaller than you are right now? How did you get to be so big? Why did you grow? What went into your body that you turned into more of you? Right, you eat food.

Now, hold this (hand out a seed) and this (hand out a tree limb). What are you holding? In one hand you have a tree seed, sort of a baby tree, and in the other you have the limb of a tree. Which would you say is heavier?

Now we know that we eat food to grow. What does a tree eat? Where does all the tree stuff come from?

The surprising answer is, tree stuff comes mostly from the air!

Dry wood is about 93% made from chemicals in the air and about 7% made from water (the hydrogen in the water, to be precise). The soil provides almost nothing by weight to the tree, just trace elements that make up much less than 1% by weight.

So what is this stuff in the air that a tree turns into wood? Let’s find out.

Here I have vinegar, and here I have baking soda. We’re going to put some baking soda into this balloon, then attach it to the top of the drink bottle. Now you lift the balloon, so the baking soda falls into the vinegar. Watch what happens.

(balloon inflates with carbon dioxide gas)

What we're generating here is plant food. It is a gas called carbon dioxide, and it is what plants use to make stems, roots, leaves, wood, fruit, flowers, and everything else you find on a plant. And since we eat plants (or we eat animals that eat plants, or we eat animals that eat animals that eat plants, or . . .), what we're really eating is carbon dioxide.* You are a machine made of carbon. Where did that carbon come from? From right here, from carbon dioxide gas that was originally "eaten"* by a plant.

**(background information) There's another way of looking at it. We're really eating sunshine, for it is the energy in food that we're most interested in. Trees trap the energy of the Sun in sugar, which they make from carbon dioxide and water. When we eat plant food, we're harvesting the energy in the sugar. The carbon from the sugar becomes carbon dioxide, which we breathe out. When we eat other things (like steak, for instance), we can take the complex molecules like proteins and fats and turn them into us. We can also turn sugar into fat, and of course plants aren't just sugar, they also contain proteins, fat, etc., but this is all going way beyond the scope of this activity.*

Here I have a piece of charcoal. Does anyone know how charcoal is made? Charcoal is different from coal, in that charcoal is made from fresh wood. The wood is heated without oxygen, so instead of burning it breaks down into solid carbon and lots of gases like water vapor, oxygen, and lots of other things that we would probably call pollution. As the wood is heated without any oxygen, the carbon is mostly left behind and makes charcoal. When we burn charcoal in a fire, that carbon converts to carbon dioxide gas once again and goes up into the atmosphere.

Coal is, like charcoal, mostly carbon, and when it burns it releases carbon dioxide, too. Coal is also made from trees, but these trees have been dead for many millions of years.

Oil is made not of trees but mostly of ocean organisms. Like coal, it is based on carbon. When we burn coal or oil, we are releasing carbon dioxide that has been trapped in the Earth for a very long time.

The problem is that we're burning fuels like coal, oil, and natural gas at such a rapid rate that we are putting too much carbon dioxide into the atmosphere, and most scientists are concerned that this rapid rise in carbon dioxide is causing the Earth to heat up.

What's one way to remove carbon dioxide from the air? Plant more trees! Trees remove carbon dioxide and turn it into tree. How? Plant leaves contain an

amazing chemical called chlorophyll. Chlorophyll combines carbon dioxide, water, and sunlight to make sugar, and sugar is the basic building block for everything else the tree makes. Let's take a look at some chlorophyll.

Here's a spinach leaf. It isn't a tree leaf, but spinach is closely related to the plants that we call trees, and it makes sugar in exactly the same way. Tear up the spinach leaf and put the pieces in the beaker.

I'll pour some fingernail polish remover (which contains a chemical called acetone) on the leaves. Now take the spoon and gently grind the spinach leaves. The goal is to break up the spinach leaves and release the chlorophyll.

Now I'll pour the liquid into this empty beaker. Do you see the green? That's chlorophyll, the stuff in leaves that changes air into plant.

Chlorophyll has another secret, which I'm going to show you now. When light shines on chlorophyll, something kind of strange happens. The energy in the light is absorbed by the chlorophyll. In a living plant, the chlorophyll would use this energy to make sugar, which later becomes all the things a plant needs to live. But our leaves have had their chlorophyll pulled out, yet the chlorophyll is still doing its job of absorbing energy. When I shine a light on our chlorophyll, you can see that energy being released. Watch this!

See the red glow? That's the energy of this flashlight beam, being first absorbed and then released by chlorophyll.

And that's chlorophyll, the amazing chemical that helped to make this (hold up tree seed) into this (hold up branch).

That's our tree activity. Thanks for helping!

Appendix: How much CO₂ is in a tree branch weighing 1 kg (1000 g)?

The tree limb is 93% CO₂ or about 900 grams.

900 grams / 44 grams/mole (the molar weight of CO₂) = 41 moles of CO₂ in the tree limb

41 moles of CO₂ x 22.4 liters/mole (molar density of any gas) = 500 liters of CO₂ absorbed from the air to make the tree limb.

That's the equivalent of:

- 250 2-liter bottles filled with CO₂
- 500 of the baking soda-vinegar balloons (about 1 liter each)
- 75,000 burps!